Erratum

Last sentence of the Abstract should read as follows:

Incidents of bottlenose dolphin rope entanglements accounted for 16 of these cases.

Abstract—From 1992 to 1996, 153 bottlenose dolphin stranded in South Carolina, accounting for 73% of all marine mammal strandings during this period. The objectives of our study were to evaluate data from these strandings to determine 1) annual trends in strandings, 2) seasonal and spatial distribution trends, 3) life history parameters such as sex ratio and age classes, 3) seasonal trends in reproduction, and 4) the extent to which humans have played a role in causing these strandings (human interactions). The results showed that 49% of the bottlenose dolphin strandings occurred between April and July; the greatest number of strandings occurred in July (n=22). There was a significant seasonal increase in the distribution of bottlenose dolphin strandings in the northern portion of the state from November to March. Bottlenose dolphin neonates stranded in every month of the year, except March and October, and represented 19.6% of the total number of strandings with known length (n=138). Fifty-five percent (n=15) of bottlenose dolphin neonatal strandings occurred between May and July. Bottlenose dolphins determined to have died as the result of human interaction accounted for 23.1% of the total number of bottlenose dolphin strandings (excluding those for which a determination could not be made). Incidents of bottlenose dolphin entanglements in nets accounted for 16 of these cases.

Manuscript accepted 11 September 2001.
Fish. Bull. 100:258–265 (2002).

Bottlenose dolphin (*Tursiops truncatus*) strandings in South Carolina, 1992–1996

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When bottlenose dolphins (*Tursiops truncatus*) began stranding along the South Carolina coast during the 1987–88 die-off, state and federal authorities knew that it was an unusual mortality event. However, since there had been no organized marine mammal stranding network (MMSN) in the state (i.e. without standardized, historical data), the severity of the event could not be evaluated. To avoid this situation in the future, the National Marine Fisheries Service (NMFS) gave the South Carolina Department of Natural Resources (SCDNR) primary authority for the South Carolina Marine Mammal Stranding Network (SCMMSN) in January of 1991. An agreement between NMFS and SCDNR was entered into in 1992 under the Marine Mammal Protection Act (MMPA), and statewide, standardized stranding coverage was begun at that time.

In the epizootic event of 1987–88, it appeared that more than 50% of the migratory population of bottlenose dolphin perished along the eastern United States seaboard (Scott et al.[1]). As a result, the NMFS declared the coastal migratory stock of bottlenose dolphins depleted in 1993 (FR, 1993). Recommendations on data collection were set forth at the Atlantic Bottlenose Dolphin Workshop in Beaufort, North Carolina, 13–14 September 1993 (Wang et al., 1994) for the depleted coastal migratory stock of bottlenose dolphins. As a result, valuable life history data, tissue samples for histopathological and contaminant analyses, and seasonal stranding trends were obtained.

The objectives of this five-year study of stranded bottlenose dolphins in South Carolina were to determine 1) annual trends in strandings, 2) seasonal and spatial distribution trends, 3) life history parameters such as sex ratio and age classes, 3) seasonal trends in reproduction, and 4) the extent to which humans played a role in causing the strandings (human interactions). By examining the stranding data on a finer scale, we would be better prepared to evaluate any future unusual mortality event.

Methods

The South Carolina MMSN is composed of 20–25 people, including volunteers from the general public, university staff, federal, and state agency personnel. A separate group of the network, made up of SCDNR and NOS personnel and local veterinarians, respond to live stranded animals. A 1-800 telephone number, maintained by the SCDNR, receives reports from the public and transfers the information to the network volun-

[1] Scott, G. P., Burn, D. M., and L. J. Hansen. 1988. The dolphin die-off: long-term effects and recovery of the population. Proc. of the Oceans '88 Conf., NY, p. 819–823. Unpubl. manuscript. Southeast Fisheries Science Center, 75 Virginia Beach Dr., Miami, Florida 33149.

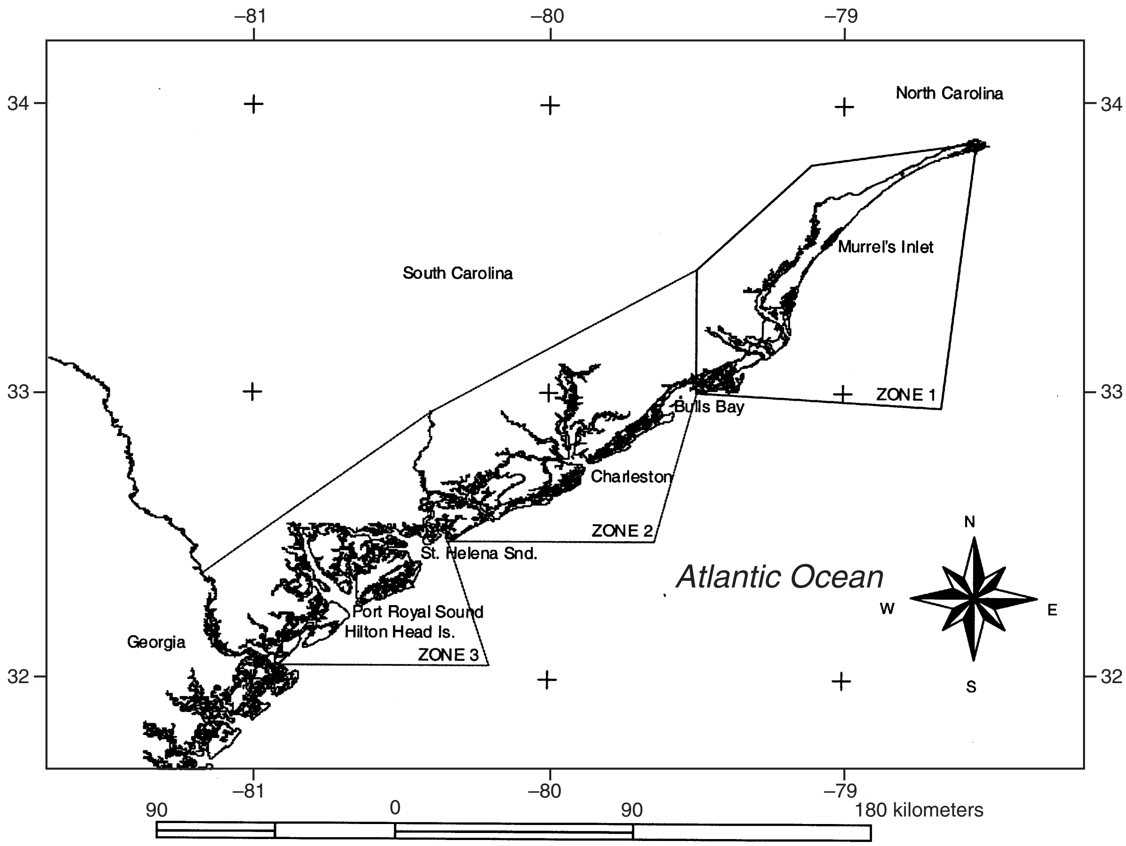

Figure 1

South Carolina coastline showing the three stranding zones: North Carolina border–Bulls Bay (zone 1), Bulls Bay–St. Helena Sound (zone 2), and St. Helena Sound–Georgia border (zone 3).

teers and the state coordinator. Since 1991, the SCDNR has flown the South Carolina coastline from Murrells Inlet to Port Royal Sound (approximately 200 km) once a month to look for stranded marine mammals on remote beaches (Fig. 1). These along-shore surveys were flown in a Cessna 180 high-wing SCDNR plane at 76 m altitude. Aerial reports were also received opportunistically from the U.S. Coast Guard, the Charleston County Sheriff's Department, and SCDNR, and reports were also received from SCDNR scientists (on the ground) who surveyed beaches for sea turtle nesting. Additional strandings were observed during aerial surveys of an investigation into dolphin mortality associated with a coastal shad-net fishery in 1995 (McFee et al., 1996).

For our study, the South Carolina coast was split into three geographical regions based on watersheds and hydrography (Brown, 1977): a northern zone (zone 1) from the North Carolina border to Bulls Bay (approximately 137 km), a central zone (zone 2) from Bulls Bay Island to St. Helena Sound (approximately 100 km), and a southern zone (zone 3) from St. Helena Sound to the Georgia border (approximately 75 km) (Fig. 1). Coverage of the coastline has been consistent since 1992. Although coverage on remote islands was lower in winter and higher in summer, it was constant from year to year. These areas are regularly patrolled by sea turtle personnel from the SCDNR and volunteers, many of whom are also members of the marine mammal stranding network.

Level A data (Hofman, 1991) were collected from each animal. Straight lengths of each bottlenose dolphin were obtained by measuring in centimeters (cm) from the tip of the upper jaw to the fluke notch. Photographs were taken for the majority of animals and were archived at the National Ocean Survey (NOS) Charleston Laboratory. Freshly dead animals were transported to the NOS Charleston Laboratory for necropsy or examined at the site of stranding according to NOS Charleston Laboratory protocol (Galloway and Colbert[2]). Animals in a moderate state of decomposition were not fully examined, but life history samples such as stomachs, ovaries, and skulls were collected. Necropsy reports were catalogued at the NOS Charleston Laboratory.

All stranded marine mammals that were accessible were examined for cause of death or evidence of human interaction (or for both). Stranding network volunteers and

[2] Galloway, S. B., and A. A. Colbert. 1997. Marine forensics manual. Part 1: marine mammals. Unpubl. manuscript. Center for Coastal Environmental Health and Biomoleculer Research, 219 Ft. Johnson Rd., Charleston, South Carolina 29412.

SCDNR personnel were trained to identify characteristic signs of human interaction, such as attached gear, rope or line marks, net marks, propeller cuts, straight-edge knife cuts, puncture wounds, etc. Animals with any of these characteristics were considered to be positive for human interaction. An assessment of stomach contents (full or empty), and histopathology (when available) to determine *ante-* or *post-mortem* injuries were used to corroborate findings. Photographs, and both necropsy and pathology reports from the United States Armed Forces Institute of Pathology (AFIP, Washington, D.C.) also were used to confirm these reports. Those animals that did not show any human interaction characteristics determined with photographs, necropsy, or AFIP pathology reports were considered to have no human interaction. For animals that were too decomposed, not fully examined, examined by untrained personnel, for whom there were inconclusive findings from necropsy or pathology reports, human interactions could not be determined. Therefore, each stranded bottlenose dolphin was classified into one of three categories to determine if human interaction was a possible cause, or contributing factor, in the death of the animals: 1) positive human interaction, 2) no human interaction, and 3) human interaction could not be determined (CBD).

Trends in the stranding data related to year, month, season, gender, and two specific age classes: neonate and females ≥220 cm, were investigated by using chi-square (χ^2) goodness-of-fit and analysis-of-variance (ANOVA) methods. A chi-square test for equal proportions was used to determine if there were differences in the number of strandings between years. An ANOVA was used to determine if there were differences in the number of strandings between months. To determine if there were seasonal trends in the strandings, the data were stratified into groups of three months representing four seasons: January–March (winter), April–June (spring), July–September (summer), and October–December (fall) (Fig. 2). Expected number of strandings for each season was determined by averaging over the 5-year period. To determine whether the stranding pattern for any given year deviated significantly from the "norm," we compared each year's seasonal number of strandings with the expected seasonal number by using a chi-square goodness-of-fit test. An ANOVA was performed to determine if there was a difference in the number of strandings between seasons. A chi-square goodness-of-fit test was used to determine seasonal trends between zones.

A chi-square goodness-of-fit test was used to determine if there was any difference in the proportion of male and female bottlenose dolphin strandings. A chi-square test for trend was used to test the hypothesis that there would be a downward trend in the number of animals that were of unknown sex due to increased training of stranding network volunteers in determining the sex of bottlenose dolphins. A chi-square goodness-of-fit test was used to determine if there was a difference in the number of strandings of females ≥220 cm between seasons.

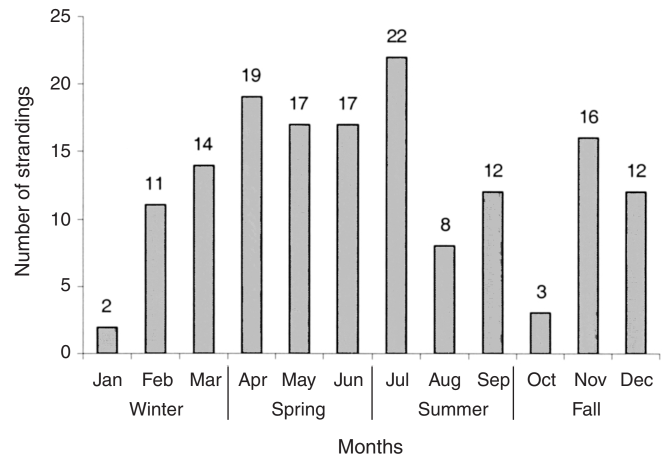

Figure 2

Number of bottlenose dolphin strandings in South Carolina for each month and season of the year from 1992 to 1996 (n=153). The numbers over each bar represent the number of strandings reported for that month.

Results

Yearly trends

From 1992 to 1996, 153 bottlenose dolphin strandings were reported along the coast of South Carolina. The number of strandings each year ranged from a low of 28 in 1992 to 33 in 1993 ($\bar{x}$=30.6) (Table 1); there was no significant difference among years (χ^2 test for equal proportions, P=0.968). Prior to 1992 the highest number of bottlenose dolphin reported stranded for one year was 17 in 1991 (the year the network was formed), excluding the unusual mortality event of 1987 (n=60).

Monthly trends

Over the five-year period, the greatest number of reports (22, or 14.4%) of bottlenose dolphin strandings occurred during July and the least in January (n=2) and October (n=3) (Fig. 2). There was no yearly differences in the total number of strandings by month from 1992 to 1996 (ANOVA, P=0.172).

Seasonal trends

The highest number of strandings occurred in spring (n=53, 34.6%) and the lowest number of strandings were recorded in winter (n=26, 17.0%). Strandings during the years 1992, 1994, 1995, and 1996 did not deviate from the expected pattern (χ^2 goodness-of-fit; P=0.994, 0452, 0.379, and 0.062, respectively), but the seasonal pattern in 1993 was significantly different (P=0.016). This was due in large part to the high number of strandings (n=14) in the fall, when we expected the number to be less than seven.

The ANOVA analysis indicated that the mean number of strandings differs significantly between seasons (P=0.021).

Table 1

Summary of results of human interaction from evaluations of bottlenose dolphins stranded in South Carolina from 1992 to 1996. "Gaff wounds" refer to puncture wounds made by the gaff, a long rigid pole with sharp point(s) used to spear fish or retrieve fishing gear.

	1992	1993	1994	1995	1996	Total
Total dolphins stranded	28	33	31	32	29	153
Human and fishery interactions						
Rope marks	2	0	0	3	4	9
Flukes cut off and mutilations	3	1	1	0	1	6
Boat strike	2	0	1	2	0	5
Blunt-object trauma	0	2	0	1	0	3
Net marks	0	0	0	0	1	1
Gaff wounds	0	1	0	0	0	1
Total	7	4	2	6	6	25
No human interaction	15	21	16	16	15	83
Human interaction could not be determined (CBD)	6	8	13	10	8	45
Percent of human or fishery interaction.[1]	31.8% (n=22)	16.0% (n=25)	11.1% (n=18)	23.1% (n=22)	28.6% (n=21)	27.3% (n=108)

[1] Calculated from total number of strandings minus CBD.

Given that 1993 was an unusual year in the stranding pattern, this year was excluded from the analysis. Specifically, the number of strandings was found to be higher in the spring than in other seasons (contrast analysis, P=0.012).

The majority of strandings occurred in the southern half of the state, zones 2 (n=67; 43.8%) and 3 (n=61; 39.9%). Seasonally, in zone 1 (n=25), 72.0% of its strandings occurred in fall and winter, whereas in zones 2 and 3, the majority of their strandings occurred in spring and summer, 68.7% and 70.5%, respectively. Seventy-three percent (n=11) of the bottlenose dolphins that stranded in the southern half of zone 1 did so between October to April. The difference in seasonal patterns of strandings between zones was significant (χ^2 goodness-of-fit; P=0.003).

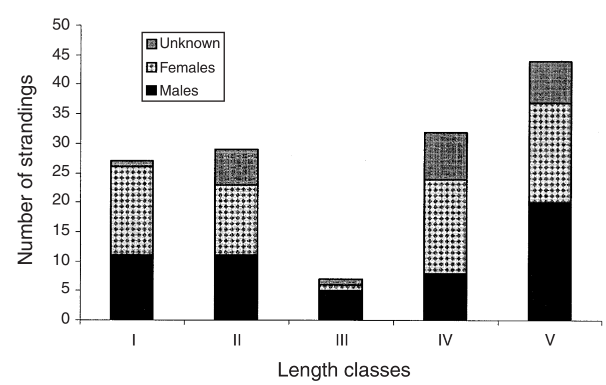

Figure 3

The number of strandings for males, females, and for bottlenose dolphin of unknown sex in each length-class stratum from 1992 to 1996 in South Carolina (class I=neonates; class II≤185 cm; class III=186–200 cm; class IV=201–240 cm; class V≥240 cm).

Gender

The total number of stranded bottlenose dolphins with known sex was 115. The sex ratio for 1992–96 was 1.00:0.89, females (n=61) to males (n=54), not significantly different from parity (χ^2 test of association; P=0.979). A significant decrease in the proportion of unknown gender occurred during the period 1992–96 (χ^2 test for trend; P=0.012) because of an increase in the number of animals examined in necropsy.

Length classes

The total number of stranded bottlenose dolphins with known length was 138. Based on length-at-age data from known bottlenose dolphins (Read et al., 1993) and stranded bottlenose dolphin data from Texas (Fernandez and Hohn, 1998) the length data were stratified into five classes: class I (neonates—defined as a newborn having a folded dorsal fin or flukes or with umbilical remnants [or with both physical features]); class II (<184 cm, young of the year); class III (185–200 cm—calves); class IV (201–240 cm, mostly physically immature, especially females); and class V (>240 cm, mostly mature) (Fig. 3).

Males and females were distributed proportionately and evenly across the length classes with the exception of two classes: class III and class IV (Fig. 4). In class III, males dominated (83.3%). Females were more prevalent in class IV (66.7%). Males showed the lowest numbers of strandings in class III (n=5) and highest numbers in class V (n=20).

Neonates Neonates represented 19.6% (n=27) of the total number (n=138) of strandings of dolphins with known length, ranging from 13.3% in 1993 to 24.1% in 1994 and were found in every month of the year, except March (Fig. 4). Twenty (74.1%) neonates stranded during the spring (n=14) and summer (n=6) months. June had the greatest number of strandings (n=7), followed by May (n=4) and November (n=4). Thirteen of the 27 neonates (48.1%) were <100 cm. Twelve of these stranded during the spring and fall months. More female neonates (1.3:1.0) stranded in South Carolina than males, though this difference was not significant (χ^2 test of association; P=781).

Twenty-four (88.9%) of the neonates stranded in zones 2 (n=13) and 3 (n=11). Neonates were found dead in the inner waterways (n=18) and along the outer beaches (n=9). Twelve of the dead neonates found in the inner waterways were retrieved while they were floating.

Females ≥220 cm Females found at a length that showed them capable of being reproductively mature (i.e. ≥220 cm) (Odell, 1975; Mead and Potter, 1990) represented approximately 50% (n=30) of the total number (n=61) of females stranded. The proportions of females ≥220 cm stranded each year were similar, with the exception of those for 1992, where only one out of seven females was this length. However, this finding may be biased, except for 1994, because of the number of animals ≥220 cm that were of unknown sex. The proportion of strandings of females ≥220 cm in each season was statistically significant (χ^2 goodness-of-fit; P=0.011). A large proportion of the lengths of female bottlenose dolphin stranded during winter (40%) and spring (40%) were ≥220 cm compared with lengths for summer (6.7%) and fall (13.3%).

Human interaction

The total number of stranded bottlenose dolphins where either human interaction or no human interaction could be determined was 108. Twenty-five bottlenose dolphin strandings, averaging five per year, showed evidence of human interaction. Eighty-three showed no signs of human interaction and 45 could not be determined (Table 1). Incidents of net entanglements, made evident by rope or line marks, net (mesh) marks, and mutilations, accounted for 16 of the human interaction cases. Incidence of confirmed human interaction on bottlenose dolphins was highest from March to July (n=18). Rope or line marks were more prevalent from February through May (n=8). The ratio of males (n=10) to females (n=11) was 1:1 in the number of positive human interactions, but there were differences in the length class and types of interaction between the sexes. Of the five males that were involved with net entanglements, four were less than 218 cm. Of the eight females associated with entanglements, seven were greater than 210 cm and six of these were >220 cm. Eighty-eight percent

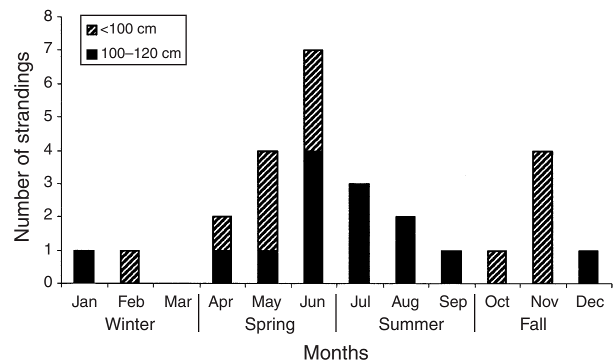

Figure 4

Total number of strandings of neonatal bottlenose dolphins in each month from1992 to1996 (n=27). Diagonally lined boxes represent those neonates <100 cm in length.

of reported human interactions occurred in zones 2 (n=10) and 3 (n=12). Preliminary analysis of stomach contents from bottlenose dolphins stranded on account of human interaction in our study showed that the majority of animals had full stomachs with shrimp or fish remains (or both) (McFee, personal obs.).

Discussion

Despite the establishment of an organized marine mammal stranding network in the southeastern United States since 1990, there has been little published on basic data from stranded bottlenose dolphins other than from reports that can be found as “gray literature.” Results from our study indicated the value of analyses of strandings and produced three main findings: 1) the northern portion (zone 1) of the state reported significantly more bottlenose dolphin strandings between November and March, 2) neonatal bottlenose dolphin strandings occurred with more frequency between May and July and 3) evidence of human interaction as the cause, or contributing factor, in the deaths of some bottlenose dolphins.

Several hypotheses regarding stock structure of Atlantic bottlenose dolphins have been proposed (Hohn, 1997). One hypothesis is that a single coastal migratory stock migrates seasonally from Long Island, New York, to the central east coast of Florida (Scott et al[3]). The other hypothesis is that multiple bottlenose dolphin stocks exist that include 1) year-round residents with small home ranges, 2) seasonal residents with large home ranges, or 3) migratory groups with long-range movements (Hohn, 1997).

Bottlenose dolphins begin to leave Virginia in mid-October and are mostly absent by mid-November (Swingle,

[3] Scott, G. P., D. M. Burn, and L. J. Hansen. 1988. The dolphin die-off: long-term effects and recovery of the population. Proc. of the Oceans ‘88 Conf., NY, p. 819–823. Unpubl. manuscript. Southeast Fisheries Science Center, 75 Virginia Beach Dr., Miami, Florida 33149.

1994; Barco et al., 1999). At about the same time, large numbers of dolphins begin to appear along the “Grand Strand” in northern South Carolina (zone 1) in October and peak in early November, according to bottlenose dolphin sighting data collected during photo-identification studies (Young[4]). During the 1987 bottlenose dolphin die-off, 52 bottlenose dolphin strandings were reported in South Carolina from October through December (Wang et al., 1994). Densities of bottlenose dolphins during a one-year aerial survey of waters from the shore to the Gulf Stream showed the greatest numbers of sightings in fall 1982 (concentrated in the Carolinas), and in winter 1983 (concentrated in northern Florida) (Wang et al., 1994).

Stranding patterns may reflect the abundance of animals. Although large numbers of dolphins occur year-round in South Carolina, there appears to be a peak in strandings in the late fall (November) which would coincide with data from Myrtle Beach (Young[4]), Charleston (Zolman, 1996), and Hilton Head Island (Petricig, 1994) in which greatest abundance of dolphins occurred in late fall. Water temperature, distribution of prey, and use of coastal shrimp trawlers have been implicated as reasons for dolphin movements and abundance in certain areas (Kenney, 1990; Mead and Potter, 1990; Bräger et al., 1994; Fertl, 1994). The late fall increase in the number of strandings in South Carolina could be due to the increased numbers of dolphins from any one of the migratory stocks suggested in the above hypotheses. Zone 1, in particular, provided evidence that a portion of the strandings is from a coastal bottlenose dolphin migratory stock or stocks. The northern half of zone 1 is known as the “Grand Strand” which extends from N. Myrtle Beach to Murrells Inlet (approximately 59 km). This area is highly populated and animals coming ashore here are found and reported regardless of the season of the year. Coverage in the southern half of zone 1 (approximately 78 km) tends to be high from May to September when the beaches are monitored for sea turtle nesting and hatching, but low during October to April. However, the majority of strandings occurred during the latter time period. This may suggest an influx of bottlenose dolphins migrating through zone 1 from October to April, either from the north or south.

We would expect bottlenose dolphin mortality to be similar to that for terrestrial mammals (Ralls et al., 1980): high neonatal and first-year mortality and high adult mortality, and an even distribution of mortality among males and females. If stranding data reflect natural mortality patterns, our results and other studies (Hersh and Duffield, 1990; Hersh et al., 1990; Wells and Scott, 1990; Fernandez and Hohn, 1998) are consistent with mortality patterns suggested for terrestrial mammals. Further, the percentage of stranded bottlenose dolphin neonates (19.6%) was intermediate when compared with that of previous studies (observations in Sarasota, Florida, 36.8% [Wells and Scott, 1990], and Indian/Banana River System, Florida, 11.2% [Hersh et al, 1990]), but similar to that of Texas (20.0% [Fernandez and Hohn, 1998]). We can only assume that mortality during the first year of life is high for bottlenose dolphins regardless of geographical location.

Age and ovarian analysis of stranded bottlenose dolphins ≥220 cm (Odell, 1975; Mead and Potter, 1990) are necessary to determine whether these animals are sexually mature and whether the seasonal patterns noted above correlated with a seasonal reproductive cycle. Seasonal reproduction cycles are complex and not well studied in the South Carolina bottlenose dolphin population but have been demonstrated where adaptations to local environmental conditions may influence seasonal reproductive cycles (Urian et al., 1996).

Over large geographic regions, bottlenose dolphins exhibit year-round calving cycles, but within small geographic regions there may be a higher degree of local reproductive seasonality (Urian et al., 1996). A unimodal seasonal distribution of neonate bottlenose dolphin strandings was noted from Sarasota, Florida, and along the Texas coast, although peak neonatal strandings occurred in different months of the year—May and March, respectively (Urian et al., 1996; Fernandez and Hohn, 1998). A bimodal seasonal distribution was noted for the east coast of Florida in the Indian River Lagoon (Urian et al., 1996). In Sarasota, Florida births have been noted in every month of the year (Urian et al., 1996). Although sample size over the five-year period for our study was too small to estimate significance of trends, our results showed a unimodal distribution and a peak number in June. However, more data may show a bimodal distribution of bottlenose dolphin neonatal strandings because of a second peak that occurred in November. These peaks do not appear to be a function of effort because the majority of neonate strandings occurred on the banks of inland waterways or the neonates were found as floating bodies. The number of neonates in the Stono River estuary, Charleston, South Carolina, peaked in the fall, during a 15-month photo-identification study (Zolman, 1996). Further, all four neonate bottlenose dolphins stranded in South Carolina in November were <100 cm; therefore these animals may have been aborted near-term fetuses.

The determination of human interaction as the cause of mortality for bottlenose dolphins is an important role of the marine mammal stranding networks and can influence management decisions. For example, the Marine Mammal Protection Act (MMPA), as amended in 1994, required that annual stock assessment reports for each stock of marine mammals be prepared. One of the items to be addressed in these reports was a description of commercial fisheries that interact with each stock and the level of mortality caused on each stock by each fishery (Waring et al., 1999). The level of mortality each fishery contributes to a stock, in turn, is essential in determining potential biological removal (PBR) estimates for the stock and the subsequent classification category that regulates each fishery (Waring et al., 1999). The current PBR for Atlantic coastal bottlenose dolphins is 25 (Waring et al., 1999). In a study on the American shad (*Alosa sapidissima*) fishery in South Carolina from 1994 to 1995, no human interactions were shown to be a cause of bottlenose dolphin mortality in the area of fishery effort (McFee et

[4] Young, R. 1998. Personal commun. Coastal Carolina University, P.O. Box 1954, Conway, SC 29526.

al., 1996). As a result, the South Carolina shad fishery retained its original classification as a category-III fishery (i.e.unlikely to take marine mammals in the course of operation) as described in the MMPA amendments of 1988.

Bottlenose dolphin mortality due to human interactions is variable along the eastern United States and Gulf of Mexico (Wang et al., 1994). Incidents of human interaction in South Carolina were also variable over our five-year study period. We believe that the number of bottlenose dolphins in our study showing positive human interaction is a minimum because determination of human interaction cases is difficult to assess owing to a lack of trained personnel, the decomposition of some carcasses, and the presumption that some interactions do not leave any physical evidence. It was a rare occurrence to have gear attached to the carcass; therefore, determination of human interaction was usually made by observing external marks such as cross-hatched lines or lines imprinted by the fishing gear. Human interaction as a cause or contributing factor in a dolphin's death can include fishery interactions (crab pots, trawls, etc.), boat collisions, gun shot wounds, environmental contaminants (agricultural run-off, pesticide use, oil spills). These interactions can result in acute (drowning in a net) or chronic (environmental contaminants) death, show physical evidence (net marks) on the body or none at all.

The percentage of human interaction cases observed in South Carolina was low compared with those in North Carolina strandings (>35% in some years; Wang et al., 1994; FR, 1997). Resident bottlenose dolphins in South Carolina appear to be exposed to different fishing operations than do bottlenose dolphins that migrate through or inhabit North Carolina waters. Net marks were the most common observation (10.5 animals per year) of human interaction cases in North Carolina (FR, 1997), whereas in South Carolina only one presumed net-caught animal was observed over a five-year period. In South Carolina incidents of entanglements as evidenced by rope or line marks are puzzling. At this time, it is highly speculative as to which fishery in South Carolina may be responsible for the incidence of entanglements associated with rope or line marks.

There is evidence to suggest that relationships exist between gender and lengths of various species of cetaceans involved with human interaction (Perrin et al., 1994; Cox et al., 1998). In our study small male bottlenose dolphins and female bottlenose dolphins ≥220 cm showed evidence that they were subject to human interaction. One study found that females with calves spent more time feeding at shrimp boats than did lone animals (Fertl, 1994). Food intake for lactating females can increase dramatically (Cockroft and Ross, 1990). Although heavy-feeding behavior may be energetically beneficial, it may also be costly to both the calf and mother by exposing them to fishing gear and predation.

In summary, the stranding data collected for bottlenose dolphins in South Carolina from 1992 to 1996 provides baseline information for the demographics, life history studies, and management concerns for comparing future stranding rates of bottlenose dolphins in South Carolina. Although it cannot be definitively stated that stranding rates coincide with a portion of a migratory stock, strandings in the northern portion (zone 1) do increase during a period of greater dolphin abundance. More years of data will further elucidate the seasonal reproduction distribution for bottlenose dolphin. Finally, the detection of human interaction as a cause or contributing factor in the deaths of some bottlenose dolphins in South Carolina has demonstrated the need to continue the effort to report these incidents for management purposes.

Acknowledgments

The authors would like to acknowledge the numerous South Carolina marine mammal stranding volunteers, past and present, who have contributed their time in the notification, recovery, transportation, and sample collection of stranded marine mammals. Without their dedication, our knowledge of marine mammals would be greatly reduced.

We would also like to thank Sylvia Galloway, Pat Fair, Larry Hansen, David Whitaker, and the reviewers and the anonymous referees of the *Fishery Bulletin*; Keith Bangerter, Lori Schwacke, and Laura Kracker for help with statistical and spatial analyses; the Armed Forces Institute of Pathology, Washington, D.C.; and finally county, state, law enforcement, town administration personnel, and the numerous concerned citizens who helped in many ways in the success of the South Carolina stranding network.

This work was made possible through NOAA's responsibility under the Marine Mammal Health and Stranding Response Act (1993), and under a Letter of Authorization issued by the National Marine Fisheries Service to the South Carolina Department of Natural Resources. Funding to support the South Carolina marine mammal stranding network comes from the South Carolina Endangered Wildlife Fund.

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